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ESTIMATING SOIL MIXING BY RODENTS

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ABSTRACT

The importance of soil mixing by prairie dogs (*Cynomys* sp) can be estimated by observation and quantification Rodent burrows, which have been filled with dark-colored surface soil, can be observed in subsoil exposed by construction activities or by natural erosion along gullies Burrow entrances surrounded by soil mounds are easily located, particularly for prairie dogs Prairie dogs have from 25 to 125 mounds per ha with 62 as an average number With this average number, a one ha area would contain 18 m^2 of mounds if their diameter is 0 6 m If new mounds were constructed at new locations each year, about 550 years would be needed to cover the entire ha with mounds Sixty-two 15-cm diameter burrows would have an area of 1 1 m^2 so that 8,800 years would be needed for a ha of burrows to be created Obviously, new burrows are not constructed each year These calculations indicate that the effect of soil mixing by rodents may be exaggerated in the literature

INTRODUCTION

Soil mixing by rodents is important in soil genesis because unweathered parent materials are moved to the surface where weathering is more rapid Several species of rodents have been reported to have a significant effect on soil development because of their burrowing activities (Joffe 1949) Nearly a complete mixing of soil has been reported in prairie dog (*Cynomys* sp) towns (Thorp 1949) Koford (1958) discussed the general relationships of prairie dogs to soils Burrow systems have been traced and described for black-tailed prairie dogs (*C ludovicianus*) in South Dakota (Sheets et al 1971)

Green (1960) reported *Cynomys* fossils in Tertiary strata in South Dakota so the species may have been present intermittently since that time Because prairie dog bones do occur in archaeological soils, prairie dogs likely have been present during the Holocene epoch and probably in interglacial intervals during the Pleistocene If prairie dogs have occurred in these soils during most of the Pleistocene, more evidence of soil mixing should have been reported in the literature The lack of evidence may be due to the fact that most studies are based on observations of surface mounds of soil dug from burrows without considering the probability that a soil profile has been altered This paper will consider this probability for prairie dogs

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METHODS

The number of prairie dog burrows in an area is generally proportional to the forage available for grazing, with about 62 burrows/ha (25/acre) being an average number according to Koford (1958), but Fitzgerald and Lechleitner (1974), Tileston and Lechleitner (1966), and Bishop and Culbertson (1976), reported 22 4, 41 9, and 34 mounds per acre Based on an average of 25 burrows/acre, a scaled model was used to estimate the number of burrows or mounds that would be exposed along the edge of a gully or trench across an area and the amount of soil mixing that would likely occur The model had 25 burrows arrayed in a 61 x 61 m area (200 x 200 ft with burrows located at ordinate and abscissa values of 20, 60, 100, 140, and 180 ft) Line transects across the model intercept mounds and burrows with a frequency that should estimate the frequency with which a gully or trench would intercept them Sixty and 150 transects were used for mounds and burrows, respectively, in the model Ends of transects across the model were located from random number tables (0 to 200 range) A second transect was located 76 cm (30 inches) away from the first to form the sides of a belt transect across the area Equations of the transect lines and the circles representing mounds or burrows were used, by substitution and solution of the resulting quadratic equation, to calculate the points where transect lines crossed the circle circumferences The lengths of the chords formed were calculated from these line-circle intercepts Areas of the circles inside the belt transects also were determined from the geometric relationships of the circles and the two parallel transect lines

RESULTS

The frequency with which a single mound and burrow was found to occur along a line transect was one in a length of 191 and 1070 m, respectively With the 76 cm wide belt transect, the respective distances were 85 m and 209 m The mean lengths of the average transect that were in a circular mound or burrow, i e 4.6 cm and 0 8 cm, are very small

Soil in 62 61-cm-diameter mounds would have an area of m²/ha If a new mound were constructed each year, 550 yrs ould be needed to cover the entire surface hectare with mounds ty-two 15-cm-diameter burrows would have an area of 1 1 /ha Eight thousand eight hundred yrs would be needed to form rows across an area Another procedure for estimating surface rage is to divide mean chord lengths for mounds and burrows the transect lengths These values are 261 and 7,860 years, ctively.

If an average mound has a diameter of 0 6 m and is 0 3 m high,

the volume of soil present would be 0 023 m³ after the 15-cm-diameter burrow is subtracted A hectare of one meter thick soil has a volume of 10,000 m³ and 62 mounds/ha would have a volume of 1 4 m³/ha More than 7,000 yrs would be needed to invert the subsoil and surface soil This estimate neglects the difference in the bulk densities of the surface and subsoil, the construction of mounds within older mounds, and the length of time a burrow is used before a new one is constructed

DISCUSSION

Soil profiles exposed along the banks of gullies and roads contain an occasional burrow, but the overall movement of subsoil to surface layers appears to be minor Dark-colored surface soil that infiltrates into burrows is very evident in the light-colored subsoil Although the organic matter, which causes the darkening, may be destroyed by oxidation, archaeologists find dark-colored infills in holes dug by prehistoric inhabitants that are several thousand years old Floodplain sediments, which accumulated at a slow rate, contain horizontally bedded layers which differ in texture and in the content of dark organic matter These sediments have little evidence of soil mixing by rodents From observations (White, 1975), Tertiary-age soft siltstone frequently contains some thin more consolidated but fractured laminae that remain in place after soils have formed through them It would not be possible to identify these laminae if rodents had mixed the soil Stratified fluvial gravels exposed in banks of gravel pits also contain little evidence of mixing of the strata although some of the gravels were deposited hundreds of thousands of years ago

No mechanism apparently has been proposed that would cause heterogenous materials to be reorganized into strata in subsoils Our calculations indicate that a long time is needed for the surface soil and subsoil to be completely mixed Based on liberal assumptions, more than 7,000 yrs would be needed for prairie dogs to move all subsoil to the surface of an area This is a minimum estimate which does not allow mixing of soil twice in the period Thus, the logical conclusions are that soil mixing by prairie dogs is not a major process in soil genesis and that rodents have no caused extensive soil mixing in South Dakota

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